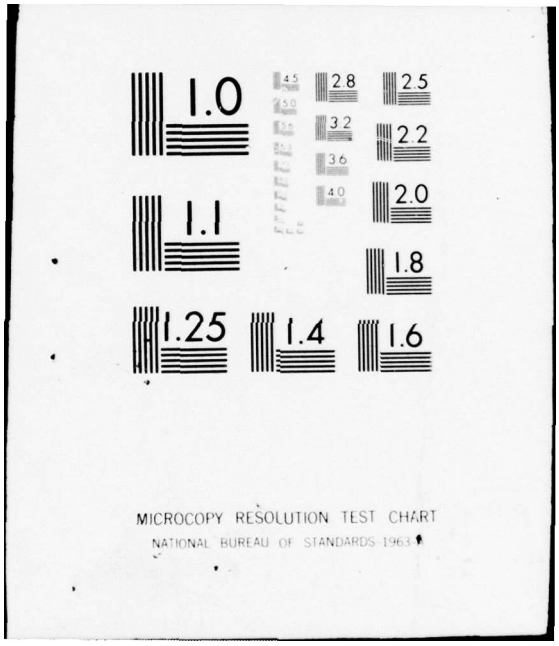
AD-A052 162 ARINC RESEARCH CORP ANNAPOLIS MD F/G 17/2.1
A STUDY OF THE ECONOMIC IMPACT OF SELECTED COMMUNICATIONS ALTER--ETC(U)
MAR 78 P WOODIE, W KOLB DOT-FAA77WA-4018
UNCLASSIFIED 1339-01-1-1723 NL

1 OF 1
AD
A052162

END
DATE
FILMED
5-78
DDC


1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
5.6
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963-A

Publication 1339-01-1-1723

A STUDY OF THE ECONOMIC IMPACT OF SELECTED COMMUNICATIONS ALTERNATIVES

PRESENT SYSTEM DEFINITION

March 1978

Prepared for

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
OFFICE OF AVIATION SYSTEM PLANS
WASHINGTON, D.C. 20591

under Contract DOT FAA77WA-4018

ARINC RESEARCH CORPORATION

(6)

A STUDY OF THE ECONOMIC IMPACT OF SELECTED COMMUNICATIONS ALTERNATIVES,

PRESENT SYSTEM DEFINITION,

(11) March 1978

(12) 148 p.

Prepared for

Department of Transportation
Federal Aviation Administration
Office of Aviation System Plans
Washington, D.C. 20591

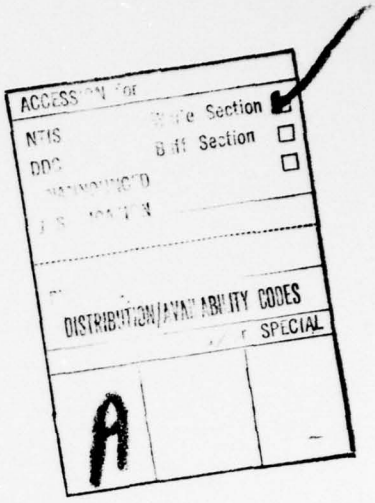
(15) under Contract DOT-FAA77WA-4018

by

(10) P. Woodie
W. Kolb

ARINC Research Corporation
a Subsidiary of Aeronautical Radio, Inc.
2551 Riva Road
Annapolis, Maryland 21401

(14) Publication 1339-01-1-1723



FOREWORD

This report presents the results of Task 1a of a seven-task effort being performed by ARINC Research Corporation for the Federal Aviation Administration (FAA), Office of Aviation System Plans under Contract DOT FAA77WA-4018. The broad objective of Task 1a is to describe the present FAA communications system in economic terms. This description will become the data base for a model that will be developed and used in subsequent tasks to analyze the economic impacts of alternative communications systems.

Most of the economic and technical data assembled herein were obtained from the following reports:

- FAA Communications Systems Description (1973) (FAA-RD-73-36)
- FAA Communications Cost Model and Projections 1975-2000, Final Report (CSC) (TR-75/3576, 1975)
- Aviation Cost Allocation Study, Working Paper No. 2 (Office of Policy Review DOT, 1972)
- Airway Facilities Maintenance Cost Data (Project Memorandum: PPA FP-604, 1976)

We wish to thank N. Weil and S. Rothschild, ASP-120, for their assistance and guidance during this phase of the project. We also acknowledge the contributions of the following individuals in providing data and granting interviews on the present communications system: J. Bisaga and D. Spokely, ARD; E. Corini, AEM; C. Wolter, J. Owen, J. Williams, P. Connelly, and T. Ford, AAF; J. Rodgers, AVP; and J. Dziuk, ATF.

SUMMARY

This report provides a description of the present FAA communications system. The data base described herein will be incorporated in a communications cost model being developed for the Federal Aviation Administration (FAA) by ARINC Research Corporation.

The economic data presented were obtained primarily from three sources: (1) the Aviation Cost Allocation Study Working Paper No. 2 (Office of Policy Review, DOT, 1972) for one-time facilities and equipment (F&E) costs; (2) the Airways Facilities Maintenance Cost Study (Project Memorandum: PPA FP-604, 1976) for operation and maintenance (O&M) costs; and (3) the DECCO Circuit File for recurring leased costs. Defining such a comprehensive communications cost data base was complicated by the fact that there is no clear definition within the FAA of what constitutes communications. For the purposes of the present cost-modeling effort, however, it is convenient to classify costs into two groups:

1. Traditional FAA communications services, including Air/Ground, Ground/Ground, Remote Link, Weather Net, AFTN, Service B, Computer B, and a miscellaneous category of additional communications functions; and

2. Services in which some (incidental) communications is required for the functioning of basic FAA systems, *viz.*, air traffic control, surveillance, and navigation.

A cost-allocation methodology was developed to separate F&E, O&M, and lease costs into each of the 11 categories adopted. To do so, it was necessary to conduct an in-depth review of more than 100 individual FAA equipment and facility types. The actual cost of each item associated with a communications function was distributed over one or more categories on the basis of several factors:

- Previous FAA studies
- Maintenance point-count data
- Equipment and facility descriptions
- Discussions with cognizant FAA offices

All costs were then inflated to 1978 dollars to establish a common base for

subsequent analyses. The value of existing facilities and equipment was converted to equivalent annual cost by using an average equipment life of 14 years and a straight line depreciation of 7 percent. Table S-1 is a summary of communications costs.

In addition to economic data, data on utilization of communications circuits is essential in the cost model for developing alternative communications systems. Unfortunately, it appears that too little of such information has been collected in the past to be useful for the present effort. Therefore, estimates based on first-hand observations and experience with similar systems are presented for each communications category. The collection of more detailed utilization data will contribute directly to more meaningful modeling results.

As a prelude to the subsequent stages of the project, this report presents several examples of the types of analyses that can be conducted by employing the communications cost data base described herein.

Table S-1. COMMUNICATIONS COST SUMMARY, ANNUAL EXPENDITURES

Communications Service Category	Annual Cost ($ Millions)			
	F&E*	O&M	Lease	Total
Traditional Communications Services				
1. Air/Ground	19.00	52.00	1.00	72.00
2. Ground/Ground	0.74	1.40	57.00	59.00
3. Remote Link	10.00	25.00	0.30	35.00
4. Weather Net	0.54	0.26	0.30	1.10
5. AFTN	0.72	1.50	None	2.20
6. Service B	None	0.98	0.20	1.20
7. Computer B	0.46	None	None	0.46
8. Miscellaneous Communications	5.00	13.00	None	18.00
Subtotal	36.46	94.14	58.80	187.96
Indirect Communications Functions				
9. Communications Related to Navigation	8.30	None	None	8.30
10. Communications Related to Surveillance	17.00	1.90	None	19.00
11. Communications Related to ATC	41.00	31.00	None	72.00
Subtotal	66.30	32.90	0.00	99.30
Total	102.76	127.04	58.80	287.26

*Based on total plant value of $1,476 million.

CONTENTS

CONTENTS (continued)

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND AND REASON FOR STUDY

The Federal Aviation Administration (FAA), in its role as manager of the National Airspace System (NAS), provides systems and facilities to meet aviation user requirements. One of these is the communications system that provides to air traffic controllers one of the tools essential for ensuring safe and efficient aircraft operation in the NAS.

The present communications system has evolved in piecemeal fashion to meet increased demands. The FAA is currently evaluating its communications needs to determine whether, how, and to what degree an integrated communications management concept can meet its needs in a more cost-effectve manner than the present fragmented system. The evaluation also addresses whether the concept can provide the additional capability and flexibility for anticipated developments in the system (such as ground-air digital data links and increased digital ground-ground communications).

The evaluation will take into account the communications needs of the FAA, the anticipated growth of these needs, changes in technology, and the development of alternative approaches for both operation and maintenance. In support of this effort, an economic alternatives analysis will be performed. A communications cost model will be developed during Task 4 of the present study for use as a tool in the economic alternatives analysis. This report, the first report of the study, presents an economic description of the present FAA communications system. The cost data will be used in the model to characterize the baseline communications system. (The baseline system consists of the present system plus any currently planned changes.)

1.2 PURPOSE OF THIS REPORT

This report is the first of three reports that will be issued during the present study. It describes the present FAA communications system, primarily from an economic perspective. The communications system economic description presented herein will become the data base for the communications cost model to be developed and used in a later phase of the study. The second report will address projected deficiencies in and alternatives to the present communications system in future years. The third and final report will address the economic impact of alternatives to the present communications system.

To assemble an economic description of FAA communications, it is first necessary to define the term *communications*: for the purpose of this study, it is defined as all facilities, equipment, and services used directly in transmitting operational information from one geographical location to another. A Remote Microwave Link (RML) is one such direct communications facility. On the other hand, an Automated Radar Terminal System (ARTS) is only indirectly involved in the transmission of information, in this case related to aircraft surveillance. Operational information is directly related to safe and efficient aircraft movements. It includes pilot/controller, controller/controller, flight plan, and similar transmissions; but it excludes any administrative communication, such as FAA Headquarters to Regional Office, which would normally be handled over the Federal Telephone System.

The costs of all operational communications facilities, equipment, and services have been included in this report. However, they have been segregated clearly into direct and indirect costs because the communications cost model (to be developed in a later task) will operate only on the costs of direct communications facilities, equipment, and services.

1.3 ORGANIZATION OF REPORT

The balance of this report consists of two chapters and four appendixes. Chapter Two contains a description of the present FAA communications system written primarily in economic terms. Sections 2.1 through 2.4 contain the service and cost categories selected, the cost allocation procedure used, and a summary of communications costs. Section 2.5 deals with circuit utilization for the various communications services.

Chapter Three describes some types and examples of analyses that will be performed with the model that will be developed later in the current contract.

Appendix A is a brief technical description of each communications service category (e.g., Service F, Service B, etc). Appendix B lists the costs associated with Operation and Maintenance (O&M) for each facility category. Appendix C lists the costs associated with Facilities and Equipment (F&E) for each facility category. Appendix D is a glossary of Alpha codes used to describe types of facilities and equipments used by the FAA.

CHAPTER TWO

DESCRIPTION OF PRESENT COMMUNICATIONS SYSTEM

This chapter is a description of the present FAA communications system. Section 2.1 describes eleven communications service categories to which communications system costs can be allocated. Section 2.2 describes how present communications costs are divided between one-time and recurring costs. Section 2.3 describes the methodology used to allocate costs into the eleven categories. Section 2.4 summarizes the communications costs as allocated to each of the eleven categories by means of the methodology described. (Detailed costs in each category are shown in Appendixes B and C.) Section 2.5 presents circuit utilization information.

The cost and utilization data contained in this report will form the nucleus of the data base for the communications cost model to be developed in the next phase of the study. The cost data base will be incremented or decremented by the cost of planned future communications systems. The utilization-data base will be used as the starting point in the configuration of shared-use systems.

2.1 COMMUNICATIONS SERVICE CATEGORIES

As the subject of FAA communications was investigated in the literature and in interviews with various FAA personnel, it became apparent that *communications* has many different meanings. On one end of the spectrum, it is viewed as consisting of only the lines and equipment leased from the various common carriers. At the other end of the spectrum, it is viewed as encompassing any equipment, line, or facility that transfers information from one point to another. *Communications*, by this definition, includes not only all leased lines and equipment, but also radios, data terminal equipments, and equipment or facilities that communicate navigation or surveillance information. This latter category includes facilities such as an Outer Marker (OM) or an Airport Surveillance Radar (ASR).

The purpose of the present cost-modeling study is to define, to categorize, and to cost communications in such a way that cost-impact analyses can be performed for various levels of communications system modifications. It is therefore important to distinguish clearly between that which is unquestionably communications and that which falls into a less well defined

area. For this reason, communications costs have been divided into costs for (1) traditional communications services and (2) communications associated with primarily noncommunications services.

Costs for traditional communications services reflect functions over which the communications manager can exercise primary control. Examples are A/G radios and G/G data communications networks. Costs for primarily noncommunications services reflect functions associated with facilities where communications is incidental to the primary function. Examples are Automated Radar Terminal Systems (ARTS) and Airport Surveillance Radars (ASR). Each of these cost types has been further divided into functional areas. The first traditional cost type has been subdivided into eight categories corresponding to traditional FAA service definitions (e.g., Air-to-Ground, Weather, and Service B). The second (primarily noncommunications) has been subdivided into three functional categories -- navigation, surveillance, and Air Traffic Control. Thus there are two broad groups that are subdivided into a total of eleven cost categories. These categories are defined in the following subsections. Included in each category definition is a list of all facilities belonging to that category.

Categories 1 through 8 reflect those costs which FAA communications services can reasonably control. It is principally these costs that will be manipulated by the model. Categories 9 through 11, on the other hand, reflect those costs for communications equipment that is an integral part of a noncommunications facility.

2.1.1 Category 1: Service F (Air/Ground)

Category 1 encompasses all clearly identifiable communications equipment and services that support A/G communications. It includes the following facilities and all land lines that support them (Appendix D is a glossary of FAA facility acronyms):

BUEC	RCO
IFSR	RTR
IFST	SFO
LRCO	SSO
RCAG	VOR

2.1.2 Category 2: Service F (Ground/Ground)

Category 2 encompasses all clearly identifiable communications equipment and services that support G/G voice communication. It includes CMLT and TELEX.

2.1.3 Category 3: Remote Link

Category 3 encompasses all clearly identifiable communications equipment and services that support remote link services, such as the remote microwave links that serve the ARSRs and any remote VHF/UHF links that connect RTRs, etc. to ATCTs or FSSs. It includes the following facilities:

CD	RMLR
LCOT	RMLT
LNKR	TROPO

2.1.4 Category 4: Weather Network

Category 4 encompasses all clearly identifiable communications equipment and services that support the Weather Network (formerly services A, C, and O). It includes OAW and WMSC.

2.1.5 Category 5: Aeronautical Fixed Telecommunication Network (AFTN)

Category 5 encompasses all clearly identifiable communications equipment and services that support the AFTN. It includes IATSC.

2.1.6 Category 6: Service B

Category 6 encompasses all clearly identifiable communications equipment and services that support the Service B networks (Area B, Utility B, and Center B networks). It includes BDIS and TTY.

2.1.7 Category 7: Computer B

Category 7 encompasses all clearly identifiable communications equipment and services that support the Computer B network. It includes FDEP.

2.1.8 Category 8: Miscellaneous Communications Facilities

Category 8 encompasses communications equipment or services that are not included in Categories 1 through 7 but are a clearly distinguishable communications part of a navigation, surveillance, or ATC facility. The costs in this category are those which could be affected by a communications program without impairing the basic facility operation. For example, improvements in the communications system, per se, could be expected to affect only perhaps 20 percent of the costs associated with an FSS. A major redesign of the basic nature of the FSS function, however, would undoubtedly have a significant effect on additional communications systems and communications costs, but these additional costs are not included in Category 8.

This category includes the following facility types for cost purposes (costs for these facility types have either been allocated wholly or partially to this Miscellaneous Communications Facilities category):

ADCOC	FSS
ARTCC	IFSS
ATCT	ORES
CKT	TOWB
COMCO	TRACO
CST	TRCAB
CTRB	TTY

2.1.9 Category 9: Communications Associated with Navigation

Category 9 encompasses all indirect communications equipment and services that (1) have primarily a navigation function, and (2) are not clearly identifiable as falling in Categories 1 through 8. It includes such items as the voice modulation portions of a VOR, which are used for A/G communication. This portion of the VOR expense is clearly for a communications-related function, but the overall facility (the VOR) is used primarily for navigation. Moreover, the voice modulation portion of a VOR is essential to its basic navigation function in that it permits accurate pilot identification of the navigation facilities being used.* A nondirectional beacon that has an A/G communications function also falls into this category. These costs can be affected substantially only by a change in the nature of the primary equipment (e.g., the VOR). For example, a decision not to use a VOR facility for communication would have virtually no effect on the basic cost of a VOR.

Facilities in this category include the following:

FM	LOC
GS	LOM
H	MM
HH	OM
IM	VOR
LDA	VOT

*While all of the voice modulation portion of a VOR will fall in Category 9, the receiver collocated with many VOR facilities and used to provide two-way communications through a VOR has been included in Category 1.

2.1.10 Category 10: Communications Associated with Surveillance

Category 10 encompasses all indirect communications equipment and services that (1) have primarily a surveillance function, and (2) are not clearly identifiable as falling into Categories 1 through 8. These costs can be affected substantially only by a change in the nature of the primary equipment (e.g., the radar).

Facilities in this category include the following:

ARSR	DF
ARTS	EDPS
ASR	RBDE
CCC	

Since none of these facilities performs communications functions that could be described in Categories 1 through 8, 100 percent of the cost of these facilities has been allocated to Category 10.

2.1.11 Category 11: Communications Associated with Air Traffic Control (ATC)

Category 11 encompasses all communications equipment and services that (1) have primarily an ATC function, and (2) are not clearly identifiable as falling in Categories 1 through 8. It includes such items as the communications portion of the Air Route Traffic Control Center (ARTCC), which forms an integral part of the ATC facility. This category also includes any items that cannot be conveniently placed in Categories 9 and 10. These costs can be affected substantially only by a change in the way the FAA implements the ATC function. For example, a telephone company type 301 switch could be replaced with a more modern unit without affecting the nature of air traffic control, and these costs would appear in Category 2. However, the air traffic controller's communications key pad is an integral part of the operating console, and this would not be replaced without affecting the nature of the total operating console. Therefore, this cost would appear in Category 11.

Facilities in this category include the following:

ADCOC	CERAP	FSS	RAPCO
ARTCC	CST	IFSS	TOWB
ATCT	CTRB	ORES	TRACO
CDC	DCC	PAR	TRCAB

A portion of the costs for some of these facilities has been allocated to Category 8. For instance, 20 percent of the cost of an FSS has been allocated to Category 8 and 80 percent to Category 11.

2.2 COMMUNICATIONS COST CATEGORIES

The FAA mission is supported at practically every point by communications. For example, controllers handle aircraft movements by communicating with both aircraft and each other. Flight plan information, weather information, and other general management information is distributed via communications facilities from the various points of origination to other points, where it is used. Communications pervades all elements of the National Airspace System (NAS).

Unfortunately, the cost of the communications in each of these support roles is not broken out as a separate line item in the FAA budget. It is therefore difficult to draw a complete picture of the cost of all communications functions within the FAA. This report focuses on extracting the communications costs from the overall FAA budget and breaking these costs down into component parts to determine the relative magnitude of the costs and how they are distributed among the various FAA facilities. These costs will be used as baseline data for the communications model to be developed.

Communications costs can be separated into two broad categories:

- Recurring costs
- Nonrecurring (one-time) costs

Recurring costs (e.g., O&M and lease costs) are for items normally procured on a periodic (usually annual) basis. These costs can be subdivided further into internal costs and external costs. Internal costs are those incurred and paid within the FAA itself, e.g., FAA maintenance personnel costs. External costs are incurred and paid outside the FAA, e.g., circuits leased from common carriers.

Nonrecurring costs are for items purchased by the FAA for use over a long period of time, e.g., ARTCCs (including all associated equipment and real estate), RCAGs, VORs, etc. These expenditures represent one-time costs of acquisition.

As this purchased equipment wears out, it must be replaced. The actual equipment replacement cost in any given year varies depending on the specific equipment replaced. On the average, however, communications equipment that the FAA uses has been assumed to have a 14-year life. Thus the average annual expenditure for capital equipment replacement will be approximately 7 percent of the total communications plant value. By using this approximation, one-time costs of acquisition can be converted into equivalent annual expenditures. This conversion is useful because it allows the costs of the existing communications plant to be compared with current FAA Facilities and Equipment (F&E) expenditures.

Similarly, the recurring (annual) costs of maintenance of communications facilities and equipment can be compared with the aggregate annual cost of maintenance of all facilities and equipment (including not only communications, but also navigation, surveillance, computers, etc.). These comparisons are useful at the outset of the present investigation of communications costs simply because they gauge the magnitude of these costs in relation to aggregate total costs.

To obtain a perspective on the magnitude of communications capital expenditures relative to all capital expenditures, an approximate comparison is useful. The planned program expenditure for R&E (1978) is $250 million.* As developed in detail in a subsequent section of this report, the equivalent annual F&D expenditure for replacement of communications equipment is $103 million. Thus communications represents roughly 40 percent of the total capital value of all FAA-owned facilities and equipment. It should be noted that this comparison represents a rough approximation that is only as valid as the estimates of the communications portions of all capital facilities. In addition, the figures were derived on the basis of an average equipment life of 14 years and the resulting straight-line depreciation rate of 7 percent. These costs are external one-time costs; they are incurred and paid outside the FAA. Figure 2-1(a) illustrates this comparison.

Operation and maintenance costs for 1978 (for all facility types) are expected to be $440 million. As developed in detail in a subsequent section of this report, the annual O&M expenditures allocated for communications facilities and equipment is $126.3 million. Thus, communications represent roughly 30 percent of the total annual O&M expense for all FAA facilities and equipment. These costs are internal recurring costs; they are incurred and paid within the FAA. Figure 2-1(b) illustrates the comparison.

External recurring costs (costs paid to non-FAA organizations) for leased telecommunications services and equipment from common carriers are expected to be $58 million in 1978. Unlike either F&E or O&M costs, these costs are entirely related to communications. Hence, communications represents 100 percent of the total annual external recurring costs for leased equipment and services.

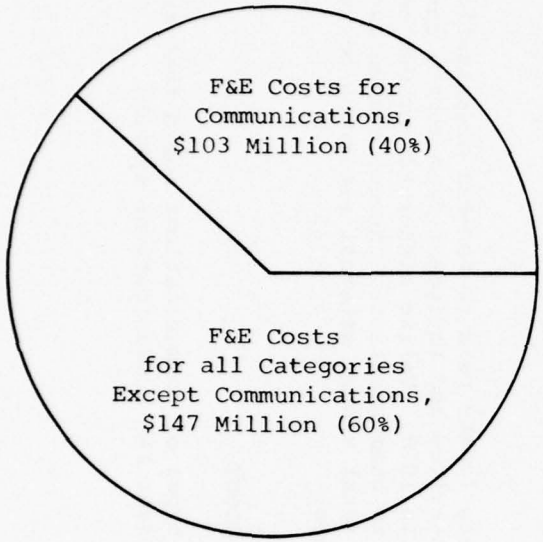
2.3 COST ALLOCATION METHODOLOGY

There are three basic types of communications costs that are incurred in conjunction with the present FAA communications system:

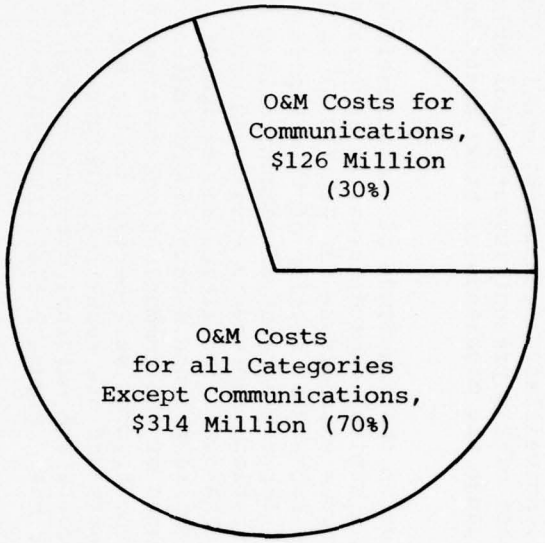
- O&M Costs
- F&E Costs
- Lease Costs

---

*_The National Aviation System Challenges of the Decade Ahead_, 1977-1986, FAA.



(a)
F&E Costs for Communications
Compared with F&E Costs for all
Other Categories



(b)
O&M Costs for Communications
Compared with O&M Costs for all
Other Categories

Figure 2-1. COMMUNICATIONS COSTS COMPARED WITH OVERALL COSTS

The methodology used to obtain communications costs in each of these categories is explained in the following three subsections.

2.3.1 O&M Costs

Figure 2-2 shows the cost-allocation procedure for O&M costs. The basic source document for determining O&M costs was the Airway Facilities Maintenance Cost Listing, compiled by the Transportation Systems Center (TSC) for the Airway Facilities Division of the FAA. This report lists FAA maintenance costs by facility type, which is defined by the Airway Facilities Sector Level Staffing Standard (FAA Order 1380.40). Examples of FAA facility categories are ARSR (Long Range Radars), ARTCC (Air Route Traffic Control Centers), RCAG (Remote Center Air/Ground Radios), LIVQ

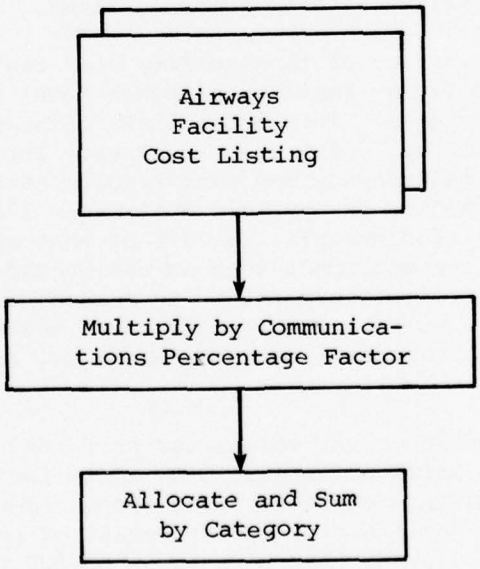


Figure 2-2. O&M COST ALLOCATION PROCEDURE

(Living Quarters), etc. The following costs are included in the maintenance cost listing:

- Maintenance Labor Costs -- all maintenance manpower expended in testing, repair, travel, training, leave, overhead, etc.
- Other Object Costs -- rental of buildings and land, utilities, building maintenance, motor vehicle repair, etc.
- Supply Support Costs -- expenditures for general stocks and stores issued to the field from the Warehouse in Oklahoma City.

Operating costs are also included in these costs to the extent that regularly assigned maintenance personnel perform standard operational functions such as transferring the sector communications facilities from day to night configuration. On the other hand, expenses such as controller and FSS specialist salaries have not been included as communications-related operations expenses.

Some of the 114 facility categories are purely communications facilities (e.g., RCAG); others are definitely not communications facilities (e.g., LIVQ). On the other hand, some facilities are partially devoted to communications and partially to some other function such as navigation. An example of a facility in this category is a VOR that has an air/ground transceiver for pilot/controller communication. Although the VOR is primarily dedicated to navigation, a part of the facility is devoted to a pure communications function. In this and similar cases, it is appropriate to assign part of the facility costs to communications.

To determine the portion of the facility cost that should be ascribed to communications, the Airway Facilities Sector Level Staffing Standard (FAA Order 1380.40) was used. This order lists maintenance staffing standards for facilities by "point count" values. These values are used to derive the actual maintenance manpower requirements at any given facility. They are divided, in Appendix 3 of Order 1380.40, into 10 tables according to function. For example, Table 1 of that appendix shows point counts for communications equipment such as radios and antennas. Table 2 shows point counts for radar equipments. By determining point count by facility type and table number, it is possible to determine the portion of total maintenance attributable to communications, to radar, and to other categories.

A compilation of point-count values was performed by the Airway Facilities Service, Manpower Section (AAF-231) for those facilities listed by the staffing standard as having functions split among communications, radar, and other categories. For example, a compilation of point counts for a sample of 2 of 23 ARTCCs shows that of a total 60,520 points allocated to ARTCC maintenance, 44,498 (74 percent) are specifically designated as communications. In a similar manner, 81 percent of maintenance expenses in an FSS were determined to be directly related to communications as opposed to some other category, such as radar.

After the communications percentage allocations were applied to each of the O&M costs listed by facility category, the costs were further subdivided (and summed) into the 11 communications service categories defined earlier. The result is the O&M cost, attributable to communications, divided into 11 categories.

A single example of this allocation procedure is provided here. The costs, percentages, and allocations for each category are shown in Appendix B. O&M costs for the ARTCC facility are listed in the Airway Facility Maintenance Cost Listing as $10,962,000 per year (adjusted from 1975 to 1978). The communications portion of these expenses is 74 percent, as discussed previously. Hence, the ATRCC contribution to the total expenses is $8,112,000 ($10,962,000 × 74%). These expenses have been further allocated to both cost Categories 8 and 11 (10% and 90%, respectively).

The allocation of the communications portion of O&M costs to each of the 11 communications cost categories is shown in Figure 2-3.

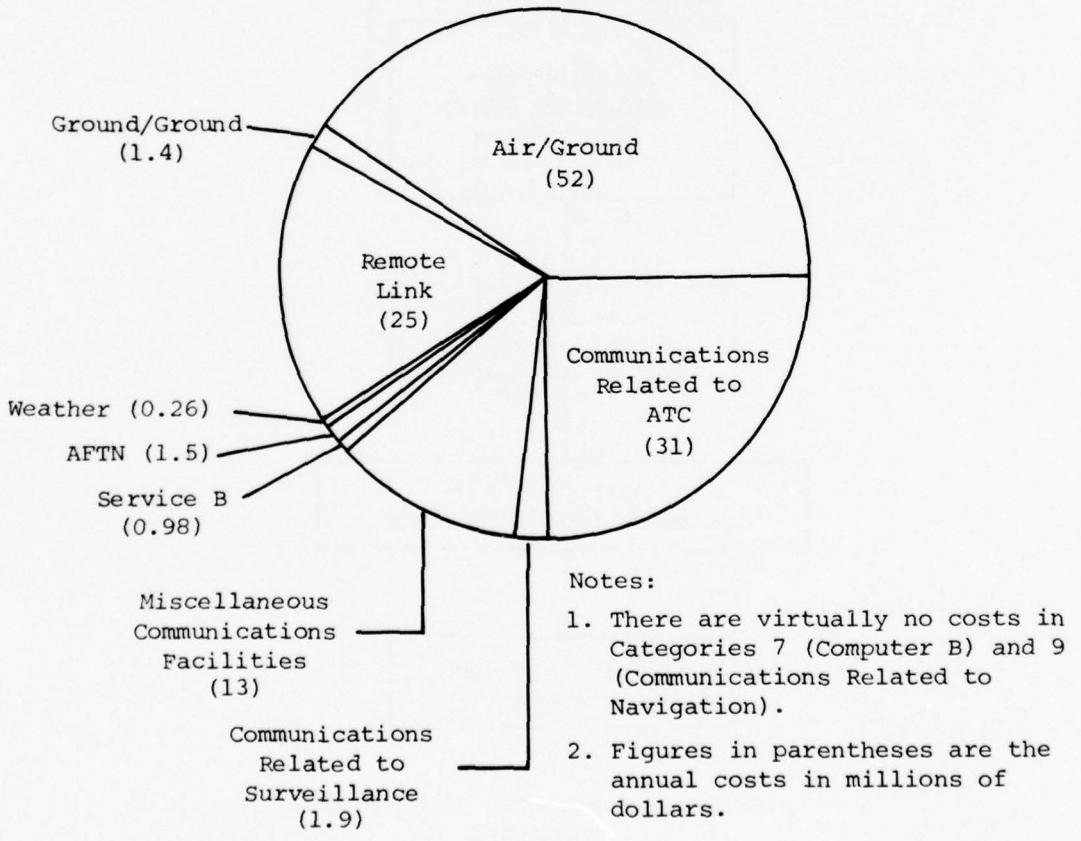


Figure 2-3. ANNUAL O&M COSTS FOR COMMUNICATIONS FACILITIES ONLY

2.3.2 F&E Costs

Figure 2-4 shows the cost-allocation procedure for F&E costs. The basic source document for determining F&E costs was the Aviation Cost Allocation Study, which provided unit costs for all FAA facilities such as ARTCCs, RCAGs, ASRs, etc. F&E costs in this study are defined as one-time capital expenditures required for the procurement and installation of new facilities or equipment, including the following items:

- Land costs
- Engineering
- Construction
- Electronic installation
- Construction material
- Electronic equipment
- Freight

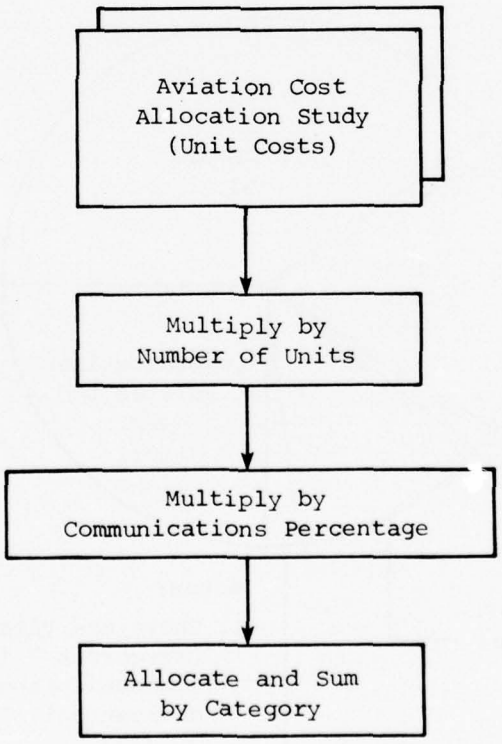


Figure 2-4. F&E COST ALLOCATION PROCEDURE

The facility average unit costs were then multiplied by the number of facilities currently in use as determined from the Maintenance Cost Study performed by the Transportation Systems Center (TSC) for AAF. The result is the capital value of all facilities of a certain type that are in use. For example, the average value of an ARTCC facility multiplied by the number of ARTCC facilities in use gives the total capital value of all ARTCC facilities.

Not all facilities are devoted strictly to communications; however, just as for O&M expenses, a percentage allocation for communications was applied to the F&E expenses category. The percentage allocations in this case were taken from a communications cost study performed for the FAA in 1975. Although they basically correspond to the O&M percentage allocations, there are some slight differences. For example, the communications portion of capital facilities and equipment for an ARTCC is 60 percent, while the communications portion of the O&M costs of an ARTCC is 74 percent. (A possible explanation is that communications maintenance technicians spend a small part of their time maintaining equipment that was procured for a noncommunications item -- a computer display system, for example.)

After the F&E percentage allocations were applied to the facility replacement costs, the resultant costs were allocated and summed into the 11 communications service categories. Facilities capital value was then translated into annual F&E expenditures by multiplying by 7 percent (based on 14-year equipment life).

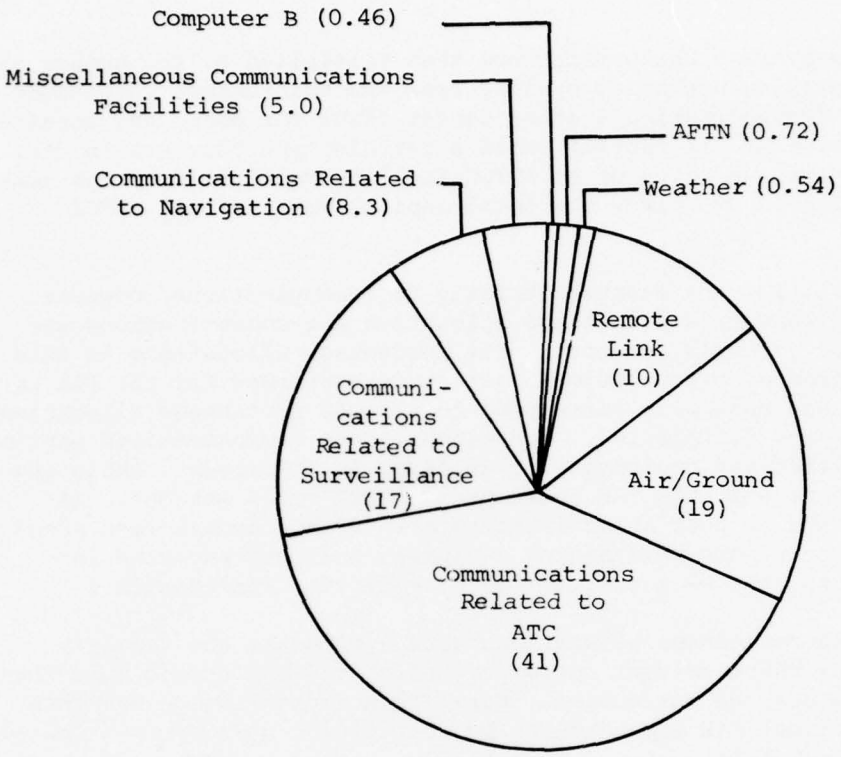
A single example will serve to illustrate the process. Capital costs for all facility categories are shown in Appendix C.

The average capital cost of an ARTCC is $20,599,400 (adjusted from 1971 costs to 1978 costs). There are 24 of these facilities, and 60 percent of their costs can be allocated to communications. Hence the ARTCC contribution to the total cost is $296,632,000 ($20,599,400 × 24 × 60%). This has been further allocated to both Categories 8 and 11 (10% and 90%, respectively). This in-place capital value is translated to annual F&E costs by multiplying by 7 percent. Thus the average annual F&E cost for ARTCC facilities is $20,818,558.

The allocation of average annual F&E costs to each of the 11 communications cost categories is shown in Figure 2-5.

2.3.3 Lease Costs

Figure 2-6 shows the cost-allocation procedures for lease costs. The basic source document for determining lease costs was the Defense Commercial Communications Office (DECCO) file listing all leased circuits and equipment. All of the items listed in this file are devoted 100 percent to a communications function. Hence, the only step necessary in the cost-allocation process was to allocate the lease costs to the 11 communications service categories. This is a relatively straightforward process since each entry in the DECCO files has a five-character Program Designator Code (PDC) that



Notes: 1. There is virtually no expense in Category 6 (Service B).

2. All figures in parentheses are annual costs in millions of dollars.

Figure 2-5. AVERAGE ANNUAL F&E COSTS FOR COMMUNICATIONS

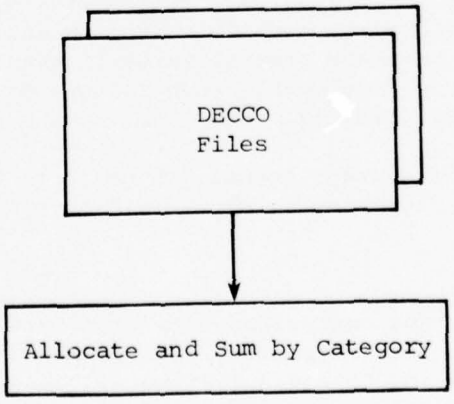


Figure 2-6. LEASE COST ALLOCATION PROCEDURE

describes the communications service with which the line entry is associated. It is a simple matter to allocate each leased item to one of the 11 communications service categories. The allocation of annual lease costs by category is shown in Figure 2-7. Virtually all of the lease expenses are for the "Interphone" or Service F (G/G), communications service.

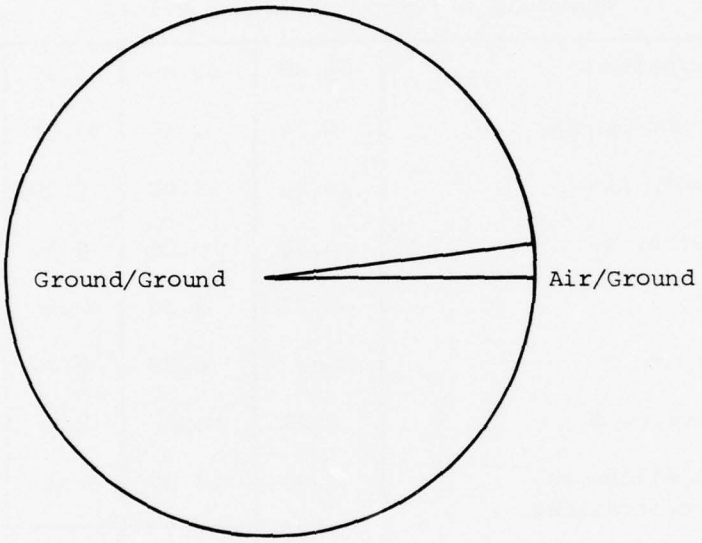


Figure 2-7. ANNUAL COMMUNICATIONS LEASE COSTS BY CATEGORY

2.4 COMMUNICATIONS COST SUMMARY

Table 2-1 is a summary of all FAA communications costs, shown both by communications service category and by type of cost (F&E, O&M, lease). The cost totals for Categories 1 through 8 have been broken out separately from the cost totals for all 11 categories because the communications cost model will treat the costs in Categories 1 through 8 differently from the way in which it treats the costs in Categories 9 through 11. The costs in the former group represent easily identifiable communications equipment that performs a distinct communications function. These costs could be subject to reduction by a communications redesign or improvement program. The costs in the latter group (Categories 9 through 11) represent the communications portion of equipment that performs primarily a noncommunications function. These costs cannot be as readily affected by a communications redesign or improvement program.

Table 2-1. COMMUNICATIONS COST SUMMARY, ANNUAL EXPENDITURES

Communications Service Category	Annual Cost ($ Millions)			
	F&E*	O&M	Lease	Total
Traditional Communications Services				
1. Air/Ground	19.00	52.00	1.00	72.00
2. Ground/Ground	0.74	1.40	57.00	59.00
3. Remote Link	10.00	25.00	0.30	35.00
4. Weather Net	0.54	0.26	0.30	1.10
5. AFTN	0.72	1.50	None	2.20
6. Service B	None	0.98	0.20	1.20
7. Computer B	0.46	None	None	0.46
8. Miscellaneous Communications	5.00	13.00	None	18.00
Subtotal	36.46	94.14	58.80	187.96
Indirect Communications Functions				
9. Communications Related to Navigation	8.30	None	None	8.30
10. Communications Related to Surveillance	17.00	1.90	None	19.00
11. Communications Related to ATC	41.00	31.00	None	72.00
Subtotal	66.30	32.90	0.00	99.30
Total	102.76	127.04	58.80	287.26

*Based on total plant value of $1,476 million.

2.5 CIRCUIT UTILIZATION

An important aspect of all communications systems is the utilization of interconnecting circuits. Since the number of circuits between any two facilities is limited, there may be occasions when demand exceeds capacity, resulting in delays and blocked calls. Systems are normally designed to accommodate the peak-busy-hour operation with a grade of service corresponding to an acceptable probability of blockage or delay.

When communications circuits are to be consolidated, it is necessary to know the peak-hour utilization of the individual circuits involved. The random nature of calling patterns usually permits significant reductions in the total number of circuits required when individual circuits are combined into a common, shared group. The opportunity to reduce FAA communications costs through this technique depends on individual circuit utilization data for all circuits. These data, however, have never been collected. For the purposes of the model being designed, estimates of circuit utilization were made on the basis of observation of ATC and tower operations as well as past experience with similar systems. These estimates are shown in Table 2-2. In most instances, the figures are somewhat lower than might be expected because of the large number of redundant circuits employed for reliability purposes. The final cost model will permit an analyst to change these values when more accurate information is available. ARINC Research will continue to refine its utilization estimates as data become available during the model development phase.

Table 2-2. BUSY-HOUR UTILIZATION

Service	Percent Utilization
Service F A/G	20
Service F G/G	10
Remote Link	80
Weather Net	25
AFTN	30
Service B	15
Computer B	80

Utilization data will be incorporated in the model to permit more comprehensive analyses of switched communications systems as alternatives to the present system. Circuits used between individual facilities involved in such an alternative will be deleted from the data base. The corresponding utilizations will be totaled and converted into a single group of circuits sufficient to meet a specified grade of service. The standard formula used for this purpose is the Erlang B queueing equation. The general procedure for reconfiguring circuits is illustrated in Figure 2-8.

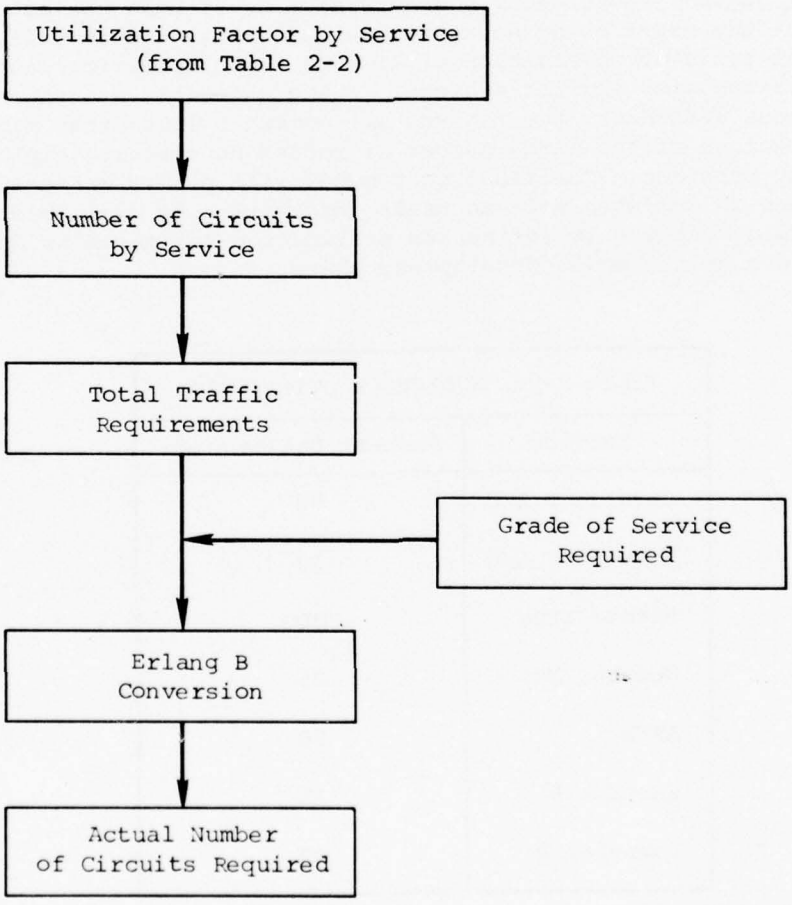


Figure 2-8. CIRCUIT RECONFIGURATION PROCEDURE

CHAPTER THREE

SAMPLE APPLICATIONS OF THE DATA BASE

The data base described in Chapter Two is an integral part of the model to be developed in Task 4 of this study. The organization of the data base is intended to permit the performance of a variety of analyses and cost projections. This chapter addresses the types of analyses that will be performed and provides an order-of-magnitude estimate for potential communications cost reductions under several scenarios.

3.1 TYPES OF ANALYSES

The communications cost model to be developed will concentrate on four major areas of communications-related costs: tariff, hardware, system, and service costs.

Tariff-related costs are associated exclusively with leased communications links or circuits within the system. A change in the number of leased circuits is a basic way in which this type of cost can be affected. Hardware-related costs are associated with equipment items and reflect future modification, replacement, and upgrading of the FAA's communications hardware.

Major modification of an entire system (as opposed to isolated items of equipment) would involve analyses of system-related costs. Such analyses would address changes to the system architecture or redesign of major FAA communications elements.

Analysis of communications services provided by the FAA would involve changes in FAA operating procedures that affect an entire service, e.g., flight service facilities.

The definition of broad analysis areas does not imply that all changes to the FAA's communications system will fall into one of four categories. In fact, most scenarios would probably fall into each category to some degree.

3.2 MODEL APPLICATIONS

This section illustrates, through examples, the four basic types of analyses for which the cost data base has been designed and to which the model can be applied. The examples show some of the ways in which the various cost categories defined in Chapter Two are influenced by changes in the method of providing communications.

3.2.1 Discontinuation of Telpak (Tariff-Related Analyses)

One application of the cost data is the analysis of communications circuit costs. Most of the FAA's communications circuits are leased under the Telpak tariff through DECCO. The bulk purchase of circuits under this tariff, coupled with effective network management and optimization by DECCO, provides the FAA with a substantial cost saving. Recently these bulk tariffs have been challenged through various FCC and court actions. As a result, they may be discontinued, and the FAA could no longer expect bulk tariffs to be available on an easily procurable basis. To determine the impact of such an event, the model would substitute the new pricing structure for circuits and compute the cost of all leased circuits. This cost would be compared with the current cost of $59 million for leased circuits shown in Chapter Two. There would be little or no effect on F&E or O&M cost as a result of the rate increase. Should the increase prove large enough, the FAA might consider constructing its own communications system. This possibility could also be analyzed with the model.

3.2.2 Modernization of RCAGs (Hardware-Related)

The FAA is currently replacing vacuum-tube equipment at all Remote Center Air/Ground facilities with solid-state equipment. These remotely controlled transmitting and receiving stations serve as outlets for ARTCCs up to several hundred miles away. An RCAG facility consists of from one to five communications channels, tone control equipment, and engine generators, all housed in a masonry building. The changeover is scheduled to be complete by 1980. The cost of retrofitting existing facilities with modern solid-state equipment can be estimated from the number of channels, sites, test equipment, spares, and miscellaneous hardware required. Some percentage of the present plant cost ($123.2 million from Appendix C, Table C-1) is for communications equipment exclusive of the building and generators. By applying this percentage to the total cost, the savings in F&E can be readily determined as the difference in the cost of the old equipment and the new equipment spread over a 14-year life.

Another benefit of solid-state equipment is reduced maintenance. Maintenance point counts can be estimated for multichannel RCAG stations under the old and new configurations and applied to the overall O&M budget for RCAGs ($19,148,000 from Table B-1, Appendix B) to obtain the potential reduction in maintenance cost. Such a modernization program would not affect leased-circuit costs.

3.2.3 Remote Maintenance Monitoring (Service-Related Analyses)

The FAA is contemplating a remote maintenance monitoring system to reduce maintenance personnel requirements. To evaluate this system, the annual O&M cost of sites requiring remote monitors would be estimated from the data in Appendix B, Table B-1. Maintenance estimates for the new service would be compared with this figure to obtain the approximate savings. Special monitoring equipment installed at remote sites would be amortized over a 14-year life and added to the F&E costs of Table C-2 (Appendix C) under an appropriate category.

Leased lines would be required to connect the remote sites to the maintenance centers. Where it was not feasible to "piggy back" data on existing lines, new circuits would be required. The costs of these circuits are calculated by using the appropriate tariff rates and are added to the leased cost of the FAA system. The net effect of all changes to F&E, O&M, and leased costs would be determined by the model. While other cost considerations might be involved, it is emphasized that the model predicts only the effect on the FAA's communications budget as defined in this report and its appendixes.

Variations that might be explored include examining the feasibility of remote maintenance on a site-by-site basis, under different tariff arrangements and under different equipment reliability considerations.

3.2.4 NADIN (System-Related)

At least 17 independent data networks are currently in use within the FAA. Each has its own trunks and equipment. A concept known as NADIN will combine these networks into a single system, permitting a significant reduction in the number of circuits required. NADIN will initially consist of 2 store-and-forward message switches plus a network of 23 concentrators. A cost-benefit analysis of this concept requires an estimate of the F&E cost associated with the new equipment. This cost would be reduced to an annual cost based on the life of the equipment and placed in an appropriate F&E category. O&M costs would increase because of the maintenance requirements for the new equipment. O&M estimates would be added to Table B-1 in Appendix B.

It is anticipated that the increase in F&E and O&M costs would be offset by a reduction in lease costs. The actual network configuration for all data circuits connected to NADIN would be priced by the model under the appropriate tariffs to obtain the net savings.

In a system consolidation such as NADIN, or any other common-user system, the circuit-reconfiguration procedure described in Section 2.5 plays a central role. The replacement system must be designed to handle traffic at the required traffic throughput standards (queue lengths, message delays, etc.). Accurate data on utilization, number of circuits, and grade of service are necessary to design a common-user system that will fulfill traffic throughput requirements.

APPENDIX A

COMMUNICATIONS SERVICE CATEGORIES

1. INTRODUCTION

This appendix presents a brief description of each of the seven communications service categories used in this report. It includes a brief overview of the function each communications service performs and the types of equipment or subsystems contained therein.

2. SERVICE F (AIR-TO-GROUND)

The air-to-ground communications subsystem supports the requirements for communicating with aircraft during all phases of flight, from initial taxi and take-off, through the en route portion of the flight, to the final approach, landing, and taxi at the destination. Communication is accomplished through VHF air-to-ground radio for civilian aircraft and UHF air-to-ground radio for military aircraft. At present, all controller/pilot air-to-ground communication is accomplished by means of voice transmission on discrete radio frequencies or channels assigned to each geographical sector. All such transmissions operate on a party-line basis between the controller and a number of aircraft in the geographical sector under consideration. Each aircraft can monitor all communications by the controller and other aircraft on the same channel. Air-to-ground communication involves VHF/UHF transmitter-receiver units (transceivers) located in both the aircraft and the ground facility. However, the cost of the equipment in the aircraft is paid by the user and not by the FAA. Since the purpose of the present study is to define and model FAA communications costs, the airborne equipment will not be discussed further.

Air-to-ground communications can be divided into three basic functional areas: (1) en route, (2) terminal, and (3) support services. En route communications systems encompass those utilized by the ARTCC for controller/pilot communication. They include air-to-ground (VHF or UHF) transmitting and receiving equipment, which is usually located at some distance from the ARTCC and connected to the ARTCC by dedicated commercial telephone lines. These remote sites, called remote center air-ground (RCAG) communications facilities, house all of the transmitting and receiving equipment necessary for multiple radio channels (usually four or more). Since air-to-ground communications is a critical function in the overall FAA mission, there is

a back-up emergency communications system (BUEC) for use in the event of a failure in the normal system. The air-to-ground facilities for this system are located at long-range radar sites.

The second broad functional area is terminal communications: controller/pilot communications during the take-off/departure and approach/landing portion of aircraft flights. This communications function is implemented by using air-ground (A/G) transceivers at remote transmitter/receiver (RTR) facilities that are similar to RCAGs but are located comparatively close to terminal facilities (such as airports) and connected to the controller facilities by dedicated commercial telephone lines. In a few cases, primarily where the distance between the controller facility and the RTR is small, FAA-owned telephone cables are used in lieu of commercial telephone services.

The third broad functional A/G area, support communications, includes all A/G communications supporting both the Flight Service Stations (FSS) and the non-tower-operated airports. Air-to-ground communications to serve this category is implemented over a rather broad range of facilities. In some cases, RTRs are used in the same manner as with the terminal communications. In other cases, the communications facilities range from remote communications outlets (RCO) and single-frequency outlets (SFO) to voice modulation of a navigational aid such as a VHF omnidirectional range (VOR) or a nondirectional beacon (H). In general, the remote air-to-ground facilities for this category of A/G communications are neither as numerous nor as extensive as the RCAGs used in the en route communications.

A more complete and detailed technical summary of the A/G communications facilities can be found in the communications system description report referenced in Chapter One, Section 1.4.

3. SERVICE F (GROUND-TO-GROUND)

The Service F Ground-to-Ground (G/G) network, sometimes known as the Interphone/Intercom Network, includes all ground point-to-point voice circuitry. It is used primarily to coordinate flight movements among controllers. Ancillary functions of the Service F (G/G) network also provide miscellaneous services such as Pilot's Automatic Telephone Weather Answering Service (PATWAS), Flight Assistance Service (FAS), and other services associated with the filing and processing of flight plans. Practically all of the information that flows over the Service F (G/G) network is time-critical in that real-time transmission and feedback is required. Otherwise, the communications would normally flow over the data communications networks (record communications networks) such as the Service B network.

The lines in the Service F network consist almost exclusively of leased commercial point-to-point telephone lines that connect ARTCCs, TRACONs, control towers, Flight Service Stations, and other facilities where there is a need for flight plan processing, transmission, or

servicing. In addition, there are lines connecting these facilities with national facilities such as the Air Traffic Control Systems Command Center (ATCSCC). Most lines are terminated at operating positions (e.g., controller) in telephone switching systems (again, leased commercial equipment) specially designed for the FAA. This equipment, the model 300 or 301 switching system, is similar to a standard key telephone system such as the Bell System model 1A1 and terminates up to 72 lines at any given position. Some pushbuttons of this system connect directly (i.e., provide direct access) to other positions, the balance connect to dial access lines (indirect access). The 300 switching system has special circuit override functions built into it so that for a higher-priority (or emergency) condition, an existing connection can be broken into. The 300 switching system is implemented with electromechanical crossbar-type switching equipment.

Most of the full-period point-to-point leased lines at FSSs, towers, and TRACONs also are terminated in Bell System key telephone systems similar to the model 1A1 system. Some FSSs and IFSSs have Automatic Call Distributor telephone systems to distribute equally among several FSS specialists the incoming call load (from, for example, pilots desiring weather briefings).

In summary, Service F (G/G) consists almost exclusively of leased point-to-point telephone lines and leased key telephone switching systems to terminate these lines. A more detailed technical description of Service F (G/G) is contained in the communications system description in Chapter One, Section 1.4.

4. REMOTE LINK SERVICES

The Remote Link Service includes all radio links that are used to transfer information from one fixed point to another where normal commercial telephone service is neither available nor suitable. This category of service consists primarily of the Remote Microwave Links (RML) and the UHF/VHF links. The RML links are wideband links used to transmit the Long Range Radar video (in either analog or digital form) to the ARTCC. The UHF/VHF links are narrowband links used primarily to transfer voice or low-speed data channels a short distance where commercial telephone service is not available. An example is a case in which a weather monitoring station is so remote that a UHF/VHF link is needed to connect the station to the nearest telephone service. Both the RMLs and the UHF/VHF links are limited to line-of-sight distances. There are also a small number of tropospheric scatter (TROPO) radio facilities used to transfer information beyond the horizon (beyond line of sight) by using tropospheric scatter principles. These facilities, however, are scarce and are used primarily in non-CONUS locations.

Each ARTCC is served by as many as eight Air Route Surveillance Radars (ARSR) geographically dispersed throughout the ARTCC area in such a way that complete radar coverage is possible. The RMLs relay the wideband

radar video information from these widely dispersed ARSR sites to the ARTCC, where it is processed and displayed for the traffic controller. Generally, these ARSR sights are located at greater than line-of-sight distances from the ARTCC so that up to ten or more microwave links (or hops) will be used in tandem. With the advent of NAS Stage A automation, the radar video is now digitized at the NAS Stage A automation, the radar video is now digitized at the ARSR site before transmission, but the RML system is still used for transmission of the analog radar video as a backup in case of failure of the digital system. In a few cases, the digitized radar video is also sent over the RML. The RML system is physically implemented with S-band microwave radio, which is frequency-modulated (FM) to carry the required information. The UHF/VHF remote links, as mentioned above, are used primarily to carry a small number of discrete voice or data channels where commercial telephone service is neither available nor suitable. These links are implemented mainly with radio modulated by some combination of AM, PM, or FM of the radio, with SSBSC modulation for any multiplexing equipment that may be required.

A more detailed technical explanation of the Remote Link Services is contained in the communications system description report referenced in Chapter One, Section 1.4.

5. WEATHER NETWORK

The Weather Network consists primarily of a series of leased low- and medium-speed data communications lines and terminals that are connected by one large store-and-forward data communications computer located at the Weather Message Switching Center (WMSC) in Kansas City, Missouri. This network represents the combination of the old Service A, C, and O weather networks. The Weather Network serves to collect and distribute weather observations, forecasts, and Notices to Airmen (NOTAMS) to FSSs, ARTCCs, airline offices, and other users.

Most of the terminals of the Weather Network are low-speed Baudot teletype terminals, although, as a result of a modernization program, an increasing number are being converted to medium-speed ASCII terminals. Virtually all of the data lines are leased from commercial common carriers. The WMSC in Kansas City is a Philips DS714 data communications switch owned and operated by the FAA.

A more detailed technical explanation of the Weather Network is contained in the communications system description report referenced in Chapter One, Section 1.4.

6. AERONAUTICAL FIXED TELECOMMUNICATIONS NETWORK (AFTN)

The AFTN is an integrated worldwide system of aeronautical fixed circuits that provides communications service for international aircraft movements, administrative messages, and operational meteorological data between the U.S. and other International Civil Aviation Organization

(ICAO) states. Each ICAO member has certain responsibilities to provide service to the AFTN. The FAA provides service to the AFTN through data switching centers and circuits in its geographical area of responsibility. The circuits are all low-speed circuits leased from both domestic and international record carriers. These circuits are connected to a large FAA-owned and -operated message switching processor located at Kansas City. This processor, a Philips DS714, is similar to the processor used for the Weather Network. There are a variety of low-speed terminals in the AFTN, the most common of which is the Teletype Model 28.

A more detailed technical explanation of the AFTN is contained in the communications system description report referenced in Chapter One, Section 1.4.

7. SERVICE B NETWORK

The Service B Network comprises a group of three area and nationwide subnetworks that are used for a variety of record communications functions, both operational and administrative: (1) the Area B Data Interchange System (BDIS), (2) the Center B network, and (3) the Utility B network. Each is a polled network devoted to a specific type of message function in the general category of flight plans or information related to the safe and expeditious control of flight movements. These three subnetworks are composed of leased full-period low-, medium- and high-speed data circuits; data terminal equipments, most of which are owned; and a small number of data switching centers, which are all FAA-owned. Brief technical descriptions of these three subnetworks is presented in the following paragraphs.

The Area B Data Interchange System (BDIS) consists of a series of low-speed polled networks, each serving an area roughly corresponding to an ARTCC area of responsibility. These low-speed networks terminate at FSSs, towers, and ARTCCs. They are all interconnected to a single medium-speed transcontinental circuit through a low- to medium-speed reperforator and switch. Record communications can therefore flow within the ARTCC area via the low-speed subnetwork or from one ARTCC area to another via the medium-speed transcontinental circuit. A Master Area B Data Interchange Network controller is located at the National Communications Center (NATCOM) in Kansas City.

The Center B network is a low-speed network that interconnects all of the ARTCCs. It is controlled by an automatic low-speed switch at the NATCOM switching center.

The Utility B network is a series of small low-speed subnetworks or lines that connect high-volume military or commercial carrier users to their respective ARTCCs. These independent networks are used to transmit IFR flight plans to ARTCCs for insertion into the Air Traffic Control (ATC) system. After the flight plan has been transmitted to the associated ARTCC, it is disseminated to other points as necessary via other record communications networks.

For a more complete technical description of the Service B record communications system, the reader is referred to the communications system description report referenced in Chapter One, Section 1.4.

8. COMPUTER B NETWORK

The Computer B Network is a medium-speed network used to interconnect the NAS Stage A computers at the ARTCCs, the Automated Terminal Radar System (ARTS) computers at the terminals, and the Flight Data Entry Printout (FDEP) data terminals. This network transfers information between NAS Stage A computers as the flight progresses from one ARTCC area to another, and between the en route computer and the ARTS computer as the aircraft approaches or departs the terminal phase of the flight. It is also used to transmit flight-progress strips from the NAS Stage A computers to the various controllers involved in handling the flight. This transmission is effected through the FDEP data terminals located at ARTCCs, terminal control locations, and towers.

The Computer B network consists of leased circuits and FAA-owned FDEP terminal equipment. For a more complete technical description, the reader is referred to the communications system description summary report referenced in Chapter One, Section 1.4.

APPENDIX B

O&M COSTS BY CATEGORY

Table B-1 shows the annual O&M costs for communications facilities used by the FAA. The first column lists all facilities that have any communications function. (The facility Alpha code is briefly described in Appendix D). The second column is the aggregate annual O&M cost for all facilities in that category. For example, the aggregate O&M cost for all facilities in the ADCOC category is $1,911,000. The third column shows the percentage of that facility maintained as a communications function as defined by Airways Facility Sector Level Staffing Standard 1380.40. The fourth column is the product of the aggregate O&M cost and the communications percentage. The remaining columns show the percentage of the cost that can be attributed to each of the 11 communications function categories. The allocation of cost among the 11 categories was developed on the basis of discussions with FAA personnel and the judgment of ARINC Research. For example, the communications portion of the aggregate cost in the ADCOC category is $172,000 ($1,911,000 × 9%). This cost can be allocated 10 percent to Communications Service Category 8 (Miscellaneous Communications Facilities) and 90 percent to Category 11 (Communications Related to ATC).

Table B-2 summarizes the totals of the costs in each category.

Table B-1. O&M COSTS

Facility	Total Cost ($ Thousands)	Communications Percentage*	Communications Cost ($ Thousands)	Percentage Assigned to Each Category										
				A/G	G/G	RML	WEA	AFTN	SVC B	COMP B	MISC	NAV	SURV	ATC
ADCOC	1,911	9	172								10			90
AID		0												
ARSR		0												
ARTCC	10,962	74	8,112								10			90
ARTS	13,507	14	1,891										100	
ASR		0												
ATCT	21,006	51	10,713								10			90
BDIS	542	100	542						100					
BUEC	2,699	100	2,699	100										
CCC		0												
CD		0												
CDC		0												
CERAP		0												
CKT	237	100	237								100			
CMLT	507	100	507		100									
COMCO	1,678	98	1,644								100			
CST		0												
CTRB		0												
DCC		0												
DF		0												
EDPS		0												
FAC		0												
FDEP		0												
FM		0												
FSS	20,252	81	16,404								20			80
GS		0												
H		0												
HH		0												
IATSC	1,464	100	1,464					100						
IFSR	585	100	585	100										
IFSS		0												
IFST	2,241	32	717	100										
IM		0												
LCOT		0												
LDA		0												
LMM		0												
LNKR	41	100	41			100								
LOC		0												
LOM		0												
LRCO	13,477	100	13,477	100										
MM		0												
OAW		0												
OM		0												
ORES		0												
PAR		0												
RAPCO		0												
RBDE		0												
RCAG	18,148	100	18,148	100										
RCO	836	100	836	100										
RMLR	16,404	100	16,404			100								
RMLT	7,915	100	7,915			100								
RTR	14,760	100	14,760	100										
SFO	717	100	717	100										
SSO	20	100	20	100										
TELEX	697	100	697		100									
TOWB		0												
TRACO	2,043	21	429								10			90
TRCAB	1,124	17	191								10			90
TROPO	147	100	147			100								
TTS	435	100	435						100					
TTY	5,926	100	5,926								100			
VOR		0												
VOT		0												
WMSC	259	100	259				100							

*Percentage Allocation based on FAA Order 1380.40, Point-Count Values.

Table B-2. O&M COST SUMMARY

Cost Category	Annual Cost ($ Thousands)
Service F (A/G)	51,959
Service F (G/G)	1,204
Remote Link	24,507
Weather	259
AFTN	1,464
Service B	977
Computer B	0
Miscellaneous Communications	13,049
Communications Related to Navigation	0
Communications Related to Surveillance	1,891
Communications Related to ATC	30,779
Total	126,089

APPENDIX C

F&E COST BY CATEGORY

Table C-1 shows the replacement costs of communications facilities used by the FAA.

The first column lists all facilities that have any communications functions. (A brief description of the facility Alpha code is presented in Appendix D). The second column is the aggregate replacement cost of all facilities in that category. For example, the total replacement cost of all facilities in the ARSR category is $319,868,000. The third column shows the estimated percentage of the facility that is devoted to a communications function. The fourth column is the product of the aggregate replacement cost and the communications percentage. The remaining columns show the percentage of the cost that can be attributed to each of the 11 communications function categories. For example, the communications portion of the aggregate cost in the ARSR category is $79,967,000 ($319,868,000 × 25%). This cost can be 100 percent allocated to Communications Service Category 10, Communications Related to Surveillance. The allocation of cost among the 11 categories was developed on the basis of a discussion with FAA personnel and the judgment of ARINC Research. The communications cost in the ARTCC facility category is $296,632,000. This cost has been allocated further as 10 percent in Communications Service Category 8 (Miscellaneous Communications Facilities) and 90 percent in Category 10 (Communications Related to ATC).

Table C-2 is a summary table showing the totals of the costs in each category.

Table C-1. F&E COSTS

Facility	Total Cost ($ Thousands)	Communications Percentage*	Communications Cost ($ Thousands)	A/G	G/G	Percentage Assigned to Each Category								
						RML	WEA	AFTN	SVC B	COMP B	MISC	NAV	SURV	ATC
ADCOC	N/A	100									10			90
AID	N/A	100									100			
ARSR	319,868	25	79,967										100	
ARTCC	494,387	60	296,632								10			90
ARTS	63,313	60	37,988										100	
ASR	153,008	25	38,252										100	
ATCT	250,059	85	212,550								10			90
BDIS	N/A	100							100					
BUEC	8,160	100	8,160	100										
CCC	226,900	25	56,725										100	
CD	18,911	100	18,911			100								
CDC	N/A	80												100
CERAP	N/A	60									10			90
CKT	832	100	832								100			
CMLT	1,190	100	1,190			100								
COMCO	720	100	720								100			
CST	21,821	85	18,548								10			90
CTRB	39,935	60	23,961								10			90
DCC	N/A	60												100
DF	11,947	100	11,947										100	
EDPS	49,372	25	12,343										100	
FAC	528	3												100
FDEP	6,595	100	6,595							100				
FM	708	25	177									100		
FSS	37,031	85	31,476								20			80
GS	57,552	25	14,388									100		
H	13,984	25	3,496									100		
HH	1,172	25	293									100		
IATSC	10,210	100	10,210					100						
IFSR	7,215	100	7,215	100										
IPSS	16,835	85	14,310								20			80
IFST	7,143	100	7,143	100										
IM	448	25	112									100		
LCOT	4,193	100	4,193			100								
LDA	604	25	151									100		
LMM	504	25	126									100		
LNKR	399	100	399			100								
LOC	96,932	25	24,233									100		
LOM	8,924	25	2,231									100		
LRCO	10,282	100	10,282	100										
MM	8,424	25	2,106									100		
OAW	212	100	212				100							
OM	8,860	25	2,215									100		
ORES	241	100	241								20			80
PAR	9,512	25	2,378											100
RAPCO	2,730	85	2,321								10			90
RBDE	43,564	25	10,891										100	
RCAG	123,197	100	123,197	100										
RCO	6,453	100	6,453	100										
RMLR	85,027	100	85,027			100								
RMLT	34,634	100	34,634											
RTR	95,234	100	95,234	100										
SFO	2,696	100	2,696	100										
SSO	227	100	227	100										
TELEX	1,059	100	1,059		100									
TOWB	31,852	60	19,111								10			90
TRACO	44,967	60	26,980								10			90
TRCAB	17,222	60	10,333								10			90
TROPO	1,838	100	1,838			100								
TTS	N/A	100							100					
TTY	N/A	100									100			
VOR	342,280	25	85,570	20								80		
VOT	780	5	39									100		
WMSC	7,551	100	7,551				100							

*Based on communications allocations developed in *FAA Communications Cost Model and Projections 1975-2000*, Final Report (CSC) (TR-75/3576, 1972).

Table C-2. F&E COST SUMMARY

Cost Category	Replacement Cost ($ Thousands)
Service F (A/G)	277,721
Service F (G/G)	1,059
Remote Link	146,192
Weather	7,763
AFTN	10,210
Service B	0
Computer B	6,595
Miscellaneous Communications	71,801
Communications Related to Navigation	118,023
Communications Related to Surveillance	248,113
Communications Related to ATC	588,608
Total	1,476,085

APPENDIX D

FACILITY CATEGORY DESCRIPTIONS

Table D-1 lists facility Alpha codes and a brief description of the facility. These facility categories are fully defined in Appendix 1 of Airway Facility Sector Level Staffing Standard System, FAA Order 1380.40 issued 12/8/76.

Table D-1. FACILITY ALPHA CODES AND DESCRIPTIONS

Alpha Code	Description
ADCOC	Air Defense Command Operation Control
ARSR	Air Route Surveillance Radar -- FAA and Military
ARTCC	Air Route Traffic Control Center
ARTS	Automated Radar Terminal System
ASR	Airport Surveillance Radar -- FAA and Military
ATCT	Airport Traffic Control Tower
BDIS	Automatic Data Interchange System, Service "B"
BRITE	Bright Radar Indicator Terminal Equipment
BUEC	Backup Emergency Communications
CCC	Central Computer Complex -- IBM-9020 System
CD	Common Digitizer
CDC	Computer Display Channel
CERAP	Combined Center/RAPCO
CKT	Control Circuit Equipment
CMLT	Communications Microwave Link Terminal
COMCO	Command Communications Outlet
CST	Combined Station/Tower
CTRB	Center Building Maintenance
DCC	Display Channel Complex
EDPS	Electronic Data Processing System
FDEP	Flight Data Entry and Printout
FSS	Flight Service Station
GS	Glide Slope
H	Homing Radio Beacon
HH	Homing Radio Beacon -- High Power
IATSC	International Aeronautical Telecommunications Switching Center
IFSR	International Flight Service Receiving Station
IFSS	International Flight Service Station
IFST	International Flight Service Transmitter Station
IM	Inner Marker

(continued)

Table D-1. (continued)

Alpha Code	Description
LCOT	VHF/UHF Link Terminal
LDA	Localizer-Type Directional Aid
LMM	Compass Locator at the ILS Middle Marker
LNKR	Link Repeater
LOC	ILS Localizer
LOM	Compass Locator at the ILS Outer Marker
LRCO	Limited Remote Communication Outlet
MM	Middle Marker
OAW	Off-Airways Weather Station
OM	Outer Marker
ORES	IFSS Residual Facility
PAR	Precision Approach Radar -- FAA and Military
RBDE	Radar Bright Display Equipment
RCAG	Remote Center Air/Ground Communications Facility
RCO	Remote Communications Outlet
RMLR	Radar Microwave Link Repeater
RMLT	Radar Microwave Link Terminal
RTR	Remote Transmitter/Receiver Facility
SFO	Single Frequency Outlet
SSO	Self-Sustained Outlet
TELEX	Telephone Exchange
TOWB	Tower Building Maintenance
TRACO	Terminal Radar Approach Control
TRCAB	Terminal Radar Approach Control in Tower Cab
TROPO	Tropospheric Scatter Station
TTS	Teletype Switching Facilities
TTY	Teletypewriter Station
VOR	VHF Omnidirectional Range
VOT	VHF Omnidirectional Range Test
WMSC	Weather Message Switching Center

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER 1339-01-1-1723	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) A STUDY OF THE ECONOMIC IMPACT OF SELECTED COMMUNICATIONS ALTERNATIVES		5. TYPE OF REPORT & PERIOD COVERED
		6. PERFORMING ORG. REPORT NUMBER 1339-01-1-1723
7. AUTHOR(s) P. Woodie W. Kolb		8. CONTRACT OR GRANT NUMBER(s) DOT FAA77WA-4018
9. PERFORMING ORGANIZATION NAME AND ADDRESS ARINC Research Corp 2551 Riva Road Annapolis, Maryland 21401		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS DEPARTMENT OF TRANSPORTATION FEDERAL AVIATION ADMINISTRATION OFFICE OF AVIATION SYSTEM PLANS		12. REPORT DATE March 1978 13. NUMBER OF PAGES 26
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) DEPARTMENT OF TRANSPORTATION FEDERAL AVIATION ADMINISTRATION OFFICE OF AVIATION SYSTEM PLANS WASHINGTON, D.C. 20591		15. SECURITY CLASS. (of this report) UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report) UNCLASSIFIED/UNLIMITED		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number)		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number)		

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)